

(19)



Europäisches Patentamt  
European Patent Office  
Office européen des brevets

(11) Publication number:

**0 050 151**  
**B1**

(12)

# EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: 28.11.84

(51) Int. Cl.<sup>3</sup>: A 01 D 55/20

(21) Application number: 81901237.8

(22) Date of filing: 13.04.81

(68) International application number:  
PCT/US81/00477(87) International publication number:  
WO 81/02967 29.10.81 Gazette 81/25

(54) MOWING MACHINE.

(30) Priority: 14.04.80 US 140254

(43) Date of publication of application:  
28.04.82 Bulletin 82/17(45) Publication of the grant of the patent:  
28.11.84 Bulletin 84/48(84) Designated Contracting States:  
AT CH DE FR GB LI LU NL SE

(58) References cited:  
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Courier Press, Leamington Spa, England.

EP 0050151 B1

## Description

This invention relates to mowing machines, and in the most common usage, to lawn mowers and grass mowing machines generally.

In the conventional "cylinder" type of lawn mower, a bed knife, which is simply an elongate knife with a straight cutting edge, is traditionally provided. Sometimes the bed knife has notched edges or teeth formed on the edge. The cylinder or "reel" is a cylindrical knife construction. Most mower cylinders are made up of a plurality of serpentine-shaped elongate knives which, together, define a notional cylindrical surface. When the cylinder rotates, the cylindrical surface of the knife construction moves adjacent the bed knife and presents a cutting configuration to the grass, weeds, and the like as the mower moves across the lawn or the field.

Another form of cylinder mower, which has been proposed in U.S.A. 2772533, utilizes elliptical discs which lie generally parallel to each other but at an angle other than a right angle relative to the shaft of the cylinder or reel and, of course, relative to the axis of the notional cylinder formed by the peripheral edges of the elliptical discs. As the cylinder or reel is rotated, the peripheral edges of the elliptical discs are presented to the bed knife in a relative cutting relationship insofar as the grass is concerned. These cylinders have never gained acceptance. While there are some advantages which would appear to result from this type of cylinder construction, these advantages have not been realized because of difficulties and problems which heretofore have not been solved. It is recognized, for example, that there is somewhat less tendency of the elliptical-disc type cylinder mowers to throw rocks and debris great distances. Somewhat taller grass can be accommodated and there is some savings in power consumption.

A number of problems have for many years remained unresolved, however.

One very serious drawback has been the tendency of these elliptical disc cylinder type mowers to give a "ripple" effect to the grass as it is mowed. As the major axis of the conventional, prior art, elliptical disc approaches the bed knife, there is a less and less acute cutting angle between the bed knife and the periphery of the disc at its major axis. Thus, the grass tends to be incompletely cut or cut somewhat longer than grass where the contact is at the minor axes of the elliptical discs. This leaves a rill of uncut or longer grass and gives a "ripple" effect to a lawn.

Another very serious problem which has affected the prior art elliptical disc type cylinder mowers is the failure of the mower cylinder to "fan" and lift and throw the grass, either into a grass catcher or to lift it and throw it so it rests lightly on the top of the newly cut grass.

An additional difficulty has been that the

discs tend to flex severely along the major axes thereof with the result that near the contact point between the major axis of a given disc and the bed knife, there becomes a wider gap which may simply widen as tough grass stems or other items come between the bed knife and the disc peripheral cutting edge. Disc failure, because of continuous flexing, has plagued such mowers as well.

US—A—3514934 describes a cutting assembly for a cylinder type mowing machine in which the cylinder or reel comprises inclined discs received on a square section shaft and having diamond shaped openings through which the shaft passes. Obtuse angled triangular support fingers are mounted on spacer collars received on the shaft and are welded to the discs. The spacer collars secure and orient the discs and transmit the driving torque to the discs.

The inventors of the present invention have experimented with other disc configurations and have made some limited development of elliptical disc cylinder type mowers in which an ear is formed on the disc. Early usages of this configuration indicated that the concept of ear formation was sound, but many problems were introduced and many of the problems of the prior art remained unsolved. Among the problems which remained unsolved were the problems that the grass was not lifted or fanned, blade failure was common, because of continuous flexing, and there still tended to be some ripple effect because along the the major axis of the disc there was residual flexing which did not provide a good cut, especially in the heavy, thick or wet grass.

The present invention is designed to solve these problems and has overcome the extremely serious problems of the prior art.

The present invention is an improvement, rather a collection of synergistically-coacting improvements, in a mowing machine which includes an elongate bed knife, a generally cylindrical rotary knife construction made up of a plurality of generally elliptical discs lying generally parallel to each other but at an angle other than a right angle to the rotary axis of a central shaft, and means for rotating the cylindrical knife construction about the rotary axis and with the peripheries of the disc forming cutting edges coacting with the bed knife, thereby presenting a cutting combination to grass and the like between the elongate knife and the respective discs.

According to the invention, the discs include adjacent the peripheral ends of the major axis of each disc ears extending away from the plane of the disc in opposite directions from said plane, the ears being so constructed and configured as to present a cutting edge at an acute angle with respect to the cutting edge of the bed knife as the disc is rotated and in that, support and fan structures extend outwardly of the shaft generally along the major axes of the discs, said

support and fan structures being so constructed and configured as to support the discs against excessive flexing along the major axes thereof and to lift and blow during the use of the machine for mowing and further in that the discs are of laminated constructions, the laminated structure comprising a central core portion of unhardened metal, said central core portion being at least two-thirds the thickness of the disc; and hardened surfaces on each side of the central core portion.

In preferred embodiments, the discs have rectangular apertures which fit over a generally square shaft, the sides of the shaft and the length of the rectangular portion of the aperture being such that the discs rest with the ends of the rectangular apertures against the sides of the square shaft such that the planes of the discs are at an angle of about 40 degrees, preferably, and generally at an angle of about 30 to 50 degrees relative to the axis of the shaft. A pair of elongate flat supporting bars extend through slots in the disc outwardly from the shaft to physically support the discs along the major axes thereof and to fan the grass or the like by the rotation of the knife construction during mowing.

In one preferred embodiment, the width of the supporting bars is greater than the length of the slots in the discs and the supporting bars have formed therein a plurality of notches which are so formed and configured that one of the notch edges lies against the surface of each of the discs, proximate to the shaft, thereby defining the angle of the discs relative to the shaft and to each other and to support the major axis of the discs beyond the ends of the notches therein.

Another important facet of preferred embodiments of the invention is a self-sharpening construction of the discs in which the planar surfaces of the discs are case hardened, or otherwise hardened such that the surfaces for a short depth, typically from about 0.13mm (0.005 inch) to about 0.63mm (0.025 inch) is harder than the relatively softer central core portion of the disc, looking perpendicular to the plane of the disc. The central core portion comprises at least about two-third of the thickness of the disc and may comprise as much as nine-tenths or more of the disc thickness. Since the centre of the disc is softer than the surfaces, the centre tends to wear more rapidly than the surfaces leaving the hardened surfaces, which are the cutting edges, extending outwardly. Thus, the disc cylinder cutting edges are self-sharpening.

The present invention will now be illustrated by reference to the accompanying drawings, in which

Figure 1 is a perspective view of an elliptical disc type of a mowing machine in accordance with this invention, showing phantom lines the driving wheels at the ends of the shaft of the knife construction;

Figure 2 is a perspective view of a single elliptical disc mounted on the shaft with the support and fan elements in place;

Figure 3 is a side view of the cylinder;

Figure 4 is an end view of the cylinder;

Figure 5 is a planar view of one of the discs used in the manufacture of the cylinder;

Figure 6 is a side view of the disc;

Figure 7 is a cross-sectional view of the disc, taken along the lines 7—7 in the direction of the arrows as shown in Figure 2, showing hardened surfaces of the disc;

Figure 8 is a side view of an improved and preferred embodiment of the cylinder, in which wider support and fan elements are used to support and back up the discs along the major axes thereof;

Figure 9 is a perspective view of the configuration of the cylinder shown in Figure 8; and

Figure 10 is a side view of a portion of one of the support and fan elements of the cylinder of Figs. 8 and 9.

Best mode for carrying out the invention

A cylinder type lawn grass and field mowing machine generally comprises an elongate bed knife 101 shown in Figure 1 in phantom lines and one or more driving wheels 102 and 103 also shown in Figure 1 in phantom. The driving wheels may be the support wheels for the mower or may be driven by some power or other means. The mower construction including the driving means may be conventional, the only difference being the improved cylinder of the mowing machine.

As shown in Figures 1 and 3, the cylinder or reel comprises a shaft 110 which has a square sectioned portion 112, the general configuration of which is best shown in Figure 4. A round portion 110 is used in the conventional way as a journal support and for attachment to whatever driving means is utilized. The significance of the square shaft is discussed hereinafter. The cylinder also has a plurality of generally elliptical discs 114 to 122. The cylinder typically, but not necessarily, also includes some partial ellipses, i.e., discs which are only partially in the form of an ellipse, being truncated so as to form the end of the cylinder. Two end pieces 124 and 126 lie generally parallel to the other elliptical discs 114 to 122 while, in the preferred embodiment, two short partial elliptical sections 128 and 130 are formed simply to square off the ends of the cylinder formed by the discs. These latter disc segments extend generally perpendicularly to the plane of the disc elements of disc segments, but otherwise work in the same manner. Insofar as the description and discussion of this invention is concerned all of these elliptical discs and disc sections will be considered elliptical discs, recognizing, of course, that incomplete elliptical discs are not full ellipses. It should also be recognized that the terms "ellipses" and "elliptical" are used

only generally and not in a precise mathematical sense. The discs of the cylinder will generally approximate to mathematical ellipses; however, no mathematical precision is to be inferred from the use of this term which describes, rather, the overall general shape and not necessarily the mathematical dimensions of the discs.

The reel also comprises a pair of support and fan elements in the form of bars 132 and 134 which extend from proximate to the shaft outwardly along the major axis of the elliptical discs. The terms "major axis" and "minor axis" are used only generally in the mathematical sense, but the elliptical discs of the mowing machine cylinder of this invention will inherently include, of course, a major axis and a minor axis.

Figure 2 depicts a single elliptical disc mounted on the shaft with the support and fan elements. Disc 118 out of the plurality of discs on the shaft is selected as exemplary to be depicted in Figure 2, and in Figures 5 and 6. In Figure 2 it will be seen that the rectangular aperture which is in the centre of the disc 118, the major axis of the rectangle corresponding to the major axis of the disc, is fitted over the square shaft 112. When so fitted, and allowed to rest at an angle, the plane of the disc resides at an angle relative to the axis of the shaft. This angle is, in the preferred embodiment about 40 degrees, but considerable variation is permitted and any angle between about 30 degrees and between about 50 degrees can be used. 40 degrees appears to be about optimum, however. The use of the square shaft aids greatly in defining the relative angles of the discs to each other and to the shaft and provides greater strength and stability and tends to overcome prior art problems to a large measure.

Another feature of the mowing machine or cylinder which is extremely valuable but do not, alone, solve the prior art problems, is the formation of ears extending, as best shown in Figure 6, in opposite directions relative to the plane of the disc, and, as best shown in Figure 5, at the respective ends of the major axis of the disc. In disc 118, these ears are identified as ears 136 and 138. These ears, formed at the periphery of the disc at the ends of the major axis of the elliptical disc, provided an acute angle and rapid relative movements between the disc periphery and the bed knife as the disc rotates such that the major axis is approaching the bed knife. In the prior art, there was very little relative lateral movement as between the periphery of the disc and the bed knife in this region. This, and other problems, resulted in "rills" and a wavy cut pattern which was undesirable from both the visual and the lawn management point of view. The inclusion of these ears tended to solve the problems with the prior art but alone was unsatisfactory because there was still considerable flexing of the blade along the major axis

which permitted some cylinder deformation notwithstanding the presence of the ears.

The combination of the square shaft to very accurately position the major axes of the discs in line with each other, the provision of the ears to provide rapid relative movement between the disc periphery at the major axis of the disc and the bed knife, and the provision of the support and fan elements 132 and 134, together have solved problems and resulted in advantages which far exceed the individual contributions of these respective elements. There is a synergistic coaction between the effects of these elements which rises far beyond the mere addition of various effects.

Another extremely significant development is depicted in Figure 7 in which the disc 118 is shown in partial cross-section. The disc 118 has a relatively soft centre core portion 140 with hardened surfaces 142 and 144. The discs themselves may be formed of relatively soft steel, although somewhat hardened steel is generally preferred. It is extremely important, however, for maximum efficiency and minimum energy usage plus the savings of cost to re-sharpening, that the surfaces of the discs, 142 and 144, be case hardened, otherwise surface hardened, relative to the central core portion 140 of the disc.

In the prior art cylinders, the peripheries of the discs tended to wear round, i.e., the edges of the discs on the surface portions wear before the centre. This resulted in a round knife edge interacting with the bed knife and often either did not cut or simply crushed the grass or other vegetation between the bed knife and the disc. This resulted in a poor quality cut and sometimes damaged the overall appearance of the lawn because of the brown resulting from crushed ends of the grass.

These problems have been overcome by providing a self-sharpening disc. It will be understood, looking at the drawings, that, as the disc periphery rotates adjacent the blade, the centre core portion of the disc will wear more rapidly than the surface portions, by reason of the dirt or other abrasive material which contacts the peripheries of the discs. This will leave hardened edge portions which cut cleanly and provide a self-sharpening effect.

A modified and, in some embodiments, preferred form of the invention is depicted in Figure 8, with individual elements being shown in Figures 9 and 10.

The embodiment of Figure 8 is identical in all respects to the embodiment of Figure 3, with the exception that the support and fan elements 132a and 134a are wider, relative to the length of the slot in the disc 118, and extend beyond the end of the slot. The elements, one of which is shown in Figure 10, as part of bar 132a include a plurality of notches one of which is shown at 132b. Each of these notches has one surface indicated at 132c in Figure 10, against which the back or acute angle surface of the

elliptical disc rests beyond the ends of the slots. This provides additional fanning action and a surprisingly greater strength to the overall structure and a longer life and better cutting as well. This result was quite surprising and it took many efforts to determine that there was such an enormous advantage from a relatively uncomplicated modification.

It will be apparent from the foregoing discussion that the present invention comprises the synergistic result of a number of variations and improvements, the sum total of which far exceeds the individual contributions of the various improvements and elements.

It will also be realized that variations may be made without departing from the scope of the claims.

### Claims

1. A mowing machine which includes an elongate bed knife (101), a generally cylindrical rotary knife construction (110—130) made up of a plurality of generally elliptical discs (114—122) lying generally parallel to each other at an angle other than a right angle to the rotary axis of a central shaft (112), and means (102—103) for rotating the cylindrical knife construction (110—128) about the rotary axis and with the peripheries of the discs forming cutting edges coacting with the bed knife (101), characterised in that the discs (114—122) include adjacent the peripheral ends of the major axis of each disc ears (136, 138) extending away from the plane of the respective disc in opposite directions from said plane, the ears (136, 138) being so constructed and configured as to present a cutting edge at an acute angle with respect to the cutting edge of the bed knife (101) as the disc is rotated, and in that support and fan structures (132, 134) extend outwardly of the shaft (112) generally along the major axes of the discs, said support and fan structures being so constructed and configured as to support the discs (114—122) against excessive flexing along the major axes thereof and to lift and blow during the use of the machine for mowing, and furthermore in that the discs (114—122) are of laminated construction, the laminated structure comprising a central core portion (140) of unhardened metal, said central core portion being at least two-thirds the thickness of the disc; and hardened surfaces (142, 144) on each side of the central core portion.

2. A mowing machine according to claim 1, in which said support and fan structures comprise elongate generally flat elements (132, 134) multiply notched to receive the discs in resting position against one portion of each notch.

3. A mowing machine according to claim 1, in which the thickness of the hardened surfaces (142, 144) is between 0.13mm (0.005 inch) and 0.63mm (0.025 inch).

4. A mowing machine as claimed in claim 1, in which the rotary knife construction (110—130) includes a generally square section shaft (112) which is received through generally rectangular apertures in the discs (114—122), and in that the sides of the shaft and the length of the rectangular apertures through the discs are so dimensioned and configured that the discs (114—122) rest with the ends of the rectangular apertures against the sides of the shaft (112) such that planes of the disc (114—122) are at an angle of from about 30 to about 50 degrees relative to the axis of the shaft.

5. A mowing machine as claimed in claim 4, in which the support and fan structures comprise flat bars (132, 134) extending through slots in the discs (114—122) outwardly from the shaft (112) towards the ears (136, 138) to physically support the discs (114—122) along the major axes thereof and to fan the grass or the like by the rotation of the knife construction during mowing.

### Revendications

1. Tondeuse qui comprend un couteau fixe allongé (101), un block rotatif, globalement cylindrique (110—130), à couteaux constitué de plusieurs disques globalement elliptiques (114—122) s'étendant globalement parallèlement les uns aux autres en formant un angle autre que droit avec l'axe de rotation d'un arbre central (112), et des moyens (102—103) destinés à faire tourner le bloc cylindrique à couteaux (110—128) autour de l'axe de rotation, les bords périphériques des disques formant des arêtes de coupe coopérant avec le couteau fixe (101), caractérisé en ce que les disques (114—122) comprennent, à proximité immédiate des extrémités périphériques du grand axe de chaque disque, des oreilles (136, 138) qui s'étendent vers l'extérieur à partir du plan du disque respectif, dans des directions opposées à partir dudit plan, les oreilles (136, 138) étant réalisées et configurées afin de présenter une arête de coupe sous un angle de coupe par rapport à l'arête de coupe du couteau fixe (101) lorsque le disque est en rotation; et en ce que des structures de support et de ventilation (132, 134) s'étendent vers l'extérieur de l'arbre (112), globalement le long des grands axes des disques; lesdites structures de support et de ventilation étant réalisées et configurées de façon à supporter les disques (114—122) pour en empêcher toute flexion excessive le long de leurs grands axes et pour produire des actions de relevage et de ventilation pendant l'utilisation sation de la tondeuse, et en outre en ce que les disques (114—122) sont de construction stratifiée, la structure stratifiée comprenant une âme centrale (140) en métal non durci, ladite âme centrale ayant au moins les deux tiers de l'épaisseur du disque; et des surfaces durcies.

(142, 144) situées sur chaque côté de l'âme centrale.

2. Tondeuse selon la revendication 1, dans laquelle lesdites structures de support et de ventilation comprennent des éléments allongés, globalement plats, (132, 134), à encoches multiples destinés à recevoir les disques en position de repos, contre une partie de chaque encoche.

3. Tondeuse selon la revendication 1, dans laquelle l'épaisseur des surfaces durcies (142, 144) est comprise entre 0,13 mm (0,005 inch) et 0,63 mm (0,025 inch).

4. Tondeuse selon la revendication 1, dans laquelle le block rotatif à couteaux (110—130) comprend un arbre (112) de section globalement carrée, que est logé dans des ouvertures globalement rectangulaires situées dans les disques (114—122), et en ce que les côtés de l'arbre et la longueur des ouvertures rectangulaires traversant les disques sont dimensionnés et configurés afin que les disques (114—122) reposent de façon que les extrémités des ouvertures rectangulaires portent contre les côtés de l'arbre (112) afin que des plans des disques (114—122) forment un angle d'environ 30° à environ 50° avec l'axe de l'arbre.

5. Tondeuse selon la revendication 4, dans laquelle les structures de support et de ventilation comprennent des barres plates (132, 134) s'étendant dans des fentes des disques (114—122) vers l'extérieur de l'arbre (112), en direction des oreilles (136—138) pour supporter physiquement les disques (114—122) le long de leurs grands axes et pour chasser l'herbe ou autre sous l'effet de la rotation du bloc à couteaux pendant la tonte.

#### Patentansprüche

1. Mähmaschine mit einem länglichen Untermesser (101), einer im wesentlichen zylindrischen drehbaren Messerkonstruktion (110 bis 130), die aus einer Vielzahl von im wesentlichen elliptischen Scheiben (114 bis 122) besteht, die allgemein parallel zueinander unter einem anderen als einem rechten Winkel gegenüber der Drehachse einer zentralen Welle (112) angeordnet sind, und mit Mitteln (102—103) zum Drehen der zylindrischen Messerkonstruktion (110 bis 130) um die Drehachse, wobei die Umfänge der Scheiben Schneidkanten bilden, die mit dem Untermesser (101) zusammenwirken, dadurch gekennzeichnet, daß die Scheiben ((114 bis 122) benachbart zu den Umfangsenden der Hauptachse jeder Scheibe Ohren (136, 138) aufweisen, die sich von der Ebene der jeweiligen Scheibe weg in entgegengesetzte Richtungen gegenüber der

Ebene erstrecken, daß die Ohren (136, 138) so konstruiert und ausgebildet sind, daß sie eine Schneidkante unter einem spitzen Winkel in bezug auf die Schneidkante des Untermessers (101) bieten, wenn die Scheibe gedreht wird, daß Stütz- und Gebläse-Teile (132, 134) sich von der Welle (112) im wesentlichen nach außen längs der Hauptachsen der Scheiben erstrecken, daß diese Stütz- und Gebläse-Teile so konstruiert und ausgebildet sind, daß sie die Scheiben (114 bis 122) gegen ein übermäßiges Verbiegen längs ihrer Hauptachsen abstützen und beim Gebrauch der Maschine zum Mähen anhebend und blasend wirken, und daß ferner die Scheiben (114 bis 122) aus einer Laminar-Konstruktion bestehen, die einen zentralen Kernteil (140) aus ungehärtetem Metall aufweist, wobei der Kernteil wenigstens zwei Drittel der Dicke der Scheibe hat, und daß gehärtete Oberflächen (142, 144) auf jeder Seite des zentralen Kernteils angeordnet sind.

2. Mähmaschine nach Anspruch 1, dadurch gekennzeichnet, daß die Stütz- und Gebläse-Teile längliche, im wesentlichen flache Elemente (132, 134) aufweisen, die mehrfach eingekerbt sind, um die Scheiben in einer Stützposition gegen einen Abschnitt jeder Kerbe aufzunehmen.

3. Mähmaschine nach Anspruch 1, dadurch gekennzeichnet, daß die Dicke der gehärteten Oberflächen (142, 144) zwischen 0,13 mm (0,005 Zoll) und 0,63 mm (0,025 Zoll) liegt.

4. Mähmaschine nach Anspruch 1, dadurch gekennzeichnet, daß die drehbare Messerkonstruktion (110 bis 130) eine Welle (112) mit im wesentlichen quadratischem Querschnitt aufweist, die durch im wesentlichen rechteckige Öffnungen in den Scheiben (114 bis 122) hindurch aufgenommen ist, und daß die Seiten der Welle und die Länge der rechteckigen Öffnungen durch die Scheiben so bemessen und ausgebildet sind, daß die Scheiben (114 bis 122) mit den Enden der rechteckigen Öffnungen gegen die Seiten der Welle (112) anliegen, so daß die Ebenen der Scheiben (114 bis 122) unter einem Winkel von etwa 30 bis etwa 50° in bezug auf die Achse der Welle angeordnet sind.

5. Mähmaschine nach Anspruch 4, dadurch gekennzeichnet, daß die Stütz- und Gebläse-Teile flache Stangen (132, 134) aufweisen, die sich durch Schlitz in den Scheiben (114 bis 122) hindurch von der Welle (112) nach außen in Richtung auf die Ohren (136 bis 138) erstrecken, um die Scheiben (114 bis 122) körperlich längs ihrer Hauptachsen abzustützen und das Gras o.dgl. durch Drehung der Messerkonstruktion während des Mähens wegzublasen.

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Fig. 1

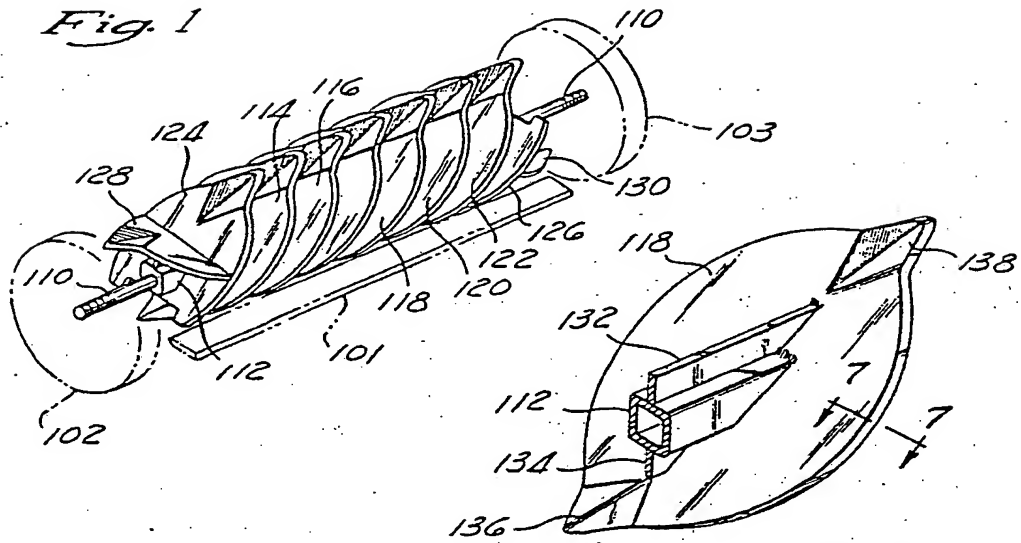


Fig. 2

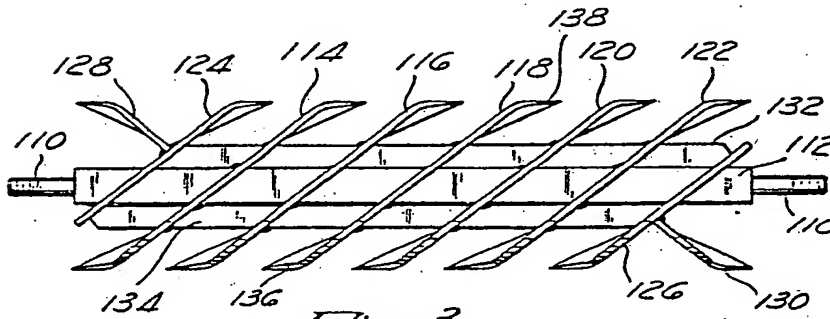


Fig. 3

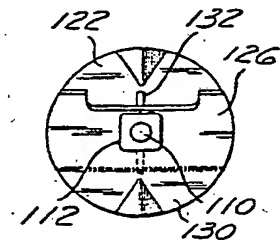


Fig. 4

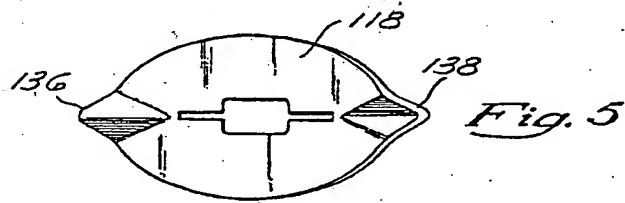


Fig. 5

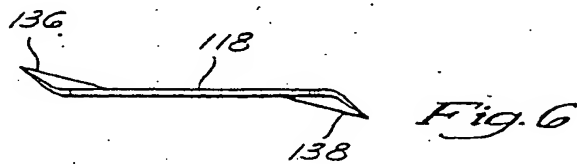


Fig. 6

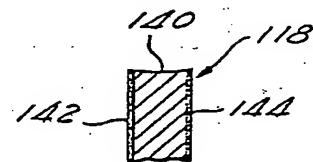


Fig. 7

